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EFFECT OF NUTRIENT INPUT ON THE SUSTAINABILITY OF SWARD COMPOSITION AND ANIMAL PRODUCTIVITY - D.A. Davies, C.T. Morgan and M. Fothergill

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ABSTRACT

An experiment was started in 1990 to study the effects of reducing input of major nutrients on the long-term sustainability of production from permanent pasture. Four treatments were imposed on a 25-year old pasture dominated by *Lolium perenne* and *Agrostis capillaris* namely: CaPKN, CaPK, Ca and no nutrients (Nil). Elimination of nutrients resulted in a rapid change in the balance between grass species in the sward. Tiller density of *Lolium perenne* declined dramatically after cessation of nutrient inputs whilst that of *Agrostis capillaris* and other unsown species increased. By 1995 *Lolium* accounted for only 24 percent of herbage DM production on the Nil treatment compared to 72 percent on the CaPKN treatment. In the same year, the contribution of *Agrostis* was 41 and 5 percent on the Nil and CaPKN treatments, respectively. Sheep carrying capacity over six years (1991-96) ranked CaPKN>CaPK>Ca>Nil. Ewe stocking rate from May to October 1996 was only 9.3 ewes ha^{-1} on the Nil sward compared to 25.5 ewes ha^{-1} on the pasture which received all four nutrients. The results show that maintenance application of major nutrients is essential for sustaining the productivity of improved permanent grassland.

INTRODUCTION

The present agricultural policy of the European Union aims to counteract overproduction by imposing quotas on livestock numbers (beef and sheep) or on output (milk). Further changes in the Common Agricultural Policy are proposed which are likely to result in lower returns for the end product. However, the EU is committed to sustaining rural communities, particularly in the Less Favoured Areas. This can only be achieved by maintaining a viable livestock industry which ultimately depends on sustaining the productivity of improved grassland.

A major reason for the deterioration in productivity of improved pastures is the disappearance of the sown species because of inadequate supply of nutrients. Soils in many grassland regions are inherently low in nutrients because of poor parent material and leaching in high rainfall areas. Maintenance of soil fertility is a significant contributor to variable costs on grassland farms. The likely scenario is that farmers will reduce input costs in an attempt to maintain profitability. The consequences of adopting such a policy are currently the subject of a long-term project at Bronydd Mawr Research Station, Powys. Results obtained over six years (1991-96) are presented in this paper.

MATERIALS AND METHODS

The experiment was started in 1990 on a 25-year old improved permanent pasture at 370-390 m above sea level on Bronydd Mawr Research Station (51°37' N, 03° 38' W), South Powys. At the start of the study the sward was *Lolium perenne/Agrostis capillaris* dominant. It had been reseeded in 1966 and last limed in 1984. The soil was acid brown earth of the Milford series

overlying Devonian red sandstone. Average annual rainfall was 1 500 mm with a mean screen temperature of 8°C.

Four treatments were imposed: CaPKN, CaPK, Ca and no nutrients (Nil). Lime was applied at 5 t ha 1 in September 1990. The plots receiving phosphorus (P) and potassium (K) were given annual applications of 25 kg ha-~ and 50 kg ha 1, respectively. Nitrogen is applied in three equal dressings giving an annual total of 150 kg ha 1 to the CaPKN treatment.

Individual plots, which were 0.4 ha and replicated three times, were continuously stocked with Brecknock Hill Cheviot ewes and their single pure-bred lambs from early May (mean date 1 May) until weaning in August (mean date 9 August) and thereafter with the ewes only until the end of October. Sward surface height was maintained at 4 ± 0.5 cm by regular adjustment of animal numbers on individual plots. The animals were weighed every 21 days.

Plant population densities were monitored during the spring and autumn of each year by taking 20 cores of 5 cm diameter, at random, from individual plots. Grass tillers from each core were identified and counted as well as stolon length of *Trifolium repens.* Herbage dry matter (DM) production was measured by sampling every 21 days inside and outside exclosure cages (three per plot). Sampling to ground level was carried out using an electric sheep-shearer. A sub-sample was used for botanical analysis.

RESULTS

Plant populations

A detailed account of the changes in grass tiller number and *Trifolium repens* stolon length per unit area of ground during the first three years was published earlier (Fothergill *et al.*, 1994). More detailed analysis of changes in grass tiller populations and their relationship with *Trifolium repens* also appear elsewhere (Fothergill *et al.*, 1998). In this paper, only periodic changes in the tiller densities of *Lolium perenne* and Agrostis capillaris are considered since these two grasses represent the sown species and the dominant unsown species, respectively.

The initial assessment in spring 1991 showed no significant differences between treatments. Mean tiller numbers were: *Lolium perenne* (7 028 m^{-2}), Agrostis capillaris (12 294 m^{-2}) and Poa spp. (9 838 m^{-2}). *Trifolium repens* was present at 21 m m^{-2} of stolon. By November 1991, significant differences between treatments had emerged in grass tiller densities. *Lolium* had decreased by 34 percent on the Nil treatment and the population of *Agrostis* increased by 41 percent in that sward. This trend continued as highlighted by tiller densities recorded in the autumn of 1995 (Table 1).

Herbage production

Annual herbage DM production declined on the Nil and Ca treatments. Averaged over the six years, annual DM production was 5.1, 6.3, 7.1 and 9.7 t ha^{-1} on the Nil, Ca, CaPK and CaPKN treatments, respectively.

The contribution of individual species to herbage DM production during the fifth year (1995) is presented in Table 2.

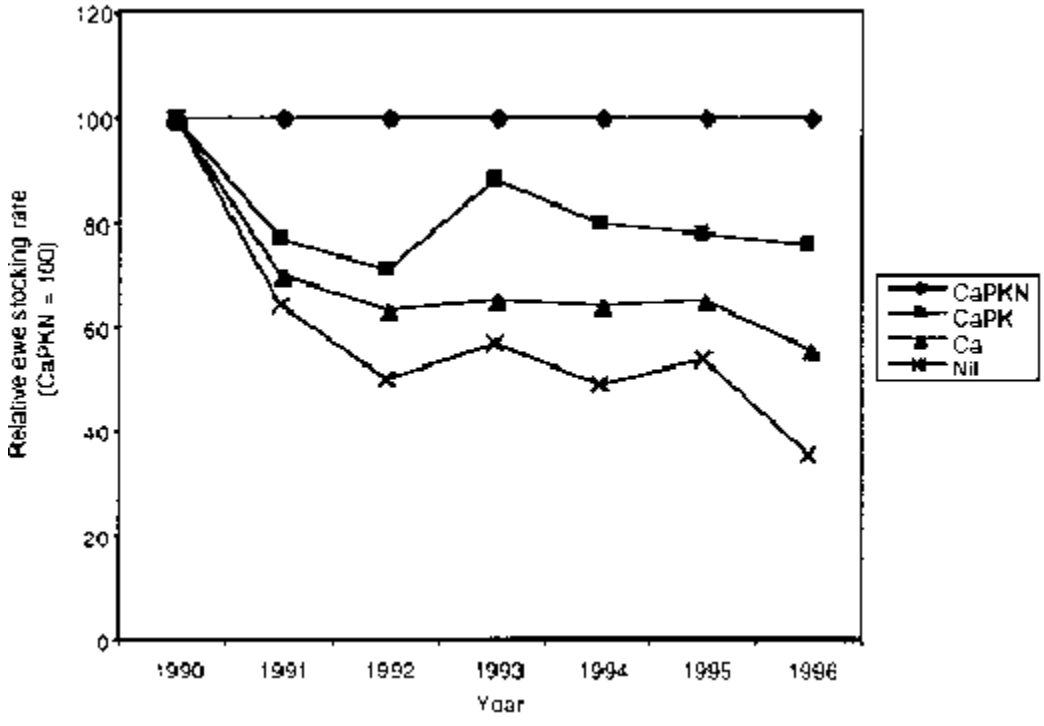
Table 1. Grass tiller density (no. m^{-2} x 103) and stolon length of *Trifolium repens* (mm^{-2}) in November 1995.

	CaPKN	CaPK	Ca	Nil
Lolium perenne	18.6	13.7	7.2	2.9
Agrostis capillaris	4.6	10.9	13.0	21.7
Poa spp.	8.3	5.1	1.9	0.1
Holcus lanatus	6.9	3.9	11.0	7.6
Other grasses	1.9	3.9	5.7	3.3
Total grasses	40.3	37.4	38.6	35.6
Trifolium repens	18.2	87.8	32.9	22.0

Table 2. Contribution (%) of species to herbage DM production, 1995.

	CaPKN	CaPK	Ca	Nil
Lolium perenne	72.2	67.3	51.9	23.6
Agrostis capillaris	4.5	6.8	16.7	41.4
Poa spp.	10.8	6.8	2.8	0.9
Other grasses	10.5	9.7	18.4	21.8
Trifolium repens	1.7	7.4	3.3	2.9
Other dicotyledons	0.3	2.0	6.9	9.4

Figure 1. Relative ewe carrying capacity (May-October) of permanent pastures receiving different nutrient inputs



Animal performance

Averaged over the six years (1991-96), lamb production, ewe stocking rate up to weaning and ewe stocking over the entire grazing season (May-October) ranked as follows: CaPKN>CaPK>Ca>Nil. Mean lamb output was 294, 368, 448 and 534 kg ha 1 from Nil, Ca, CaPK and CaPKN pastures, respectively. Overall ewe stocking rate was 14.6, 18.0, 21.9 and 28.1 ewes ha -1 on the corresponding treatments. The degree of difference between treatments increased progressively over the six years as illustrated by the relative stock carrying capacities in Figure 1.

DISCUSSION

The information from this study shows that changes in the balance between sown and unsown grass species occur rapidly following cessation of nutrient inputs. Herbage and animal productivity were also considerably affected by reduction in inputs. Soil pH declined progressively over the six years from 6.35 to 5.8 on treatments that were limed in 1990 and from 5.8 to 5.3 on the Nil treatment. The P and K status of the Ca and Nil treatments also declined over the six years.

Preliminary economic assessments of the data indicated that the saving in input costs by elimination of nutrient input was much less than the reduction in returns from animal production. This confirms that the objective of maintaining profitable livestock enterprises in grassland areas can only be successfully achieved by sustaining soil fertility at a level that is adequate for maintaining the productivity of the sown species component of improved pastures.

ACKNOWLEDGEMENT

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